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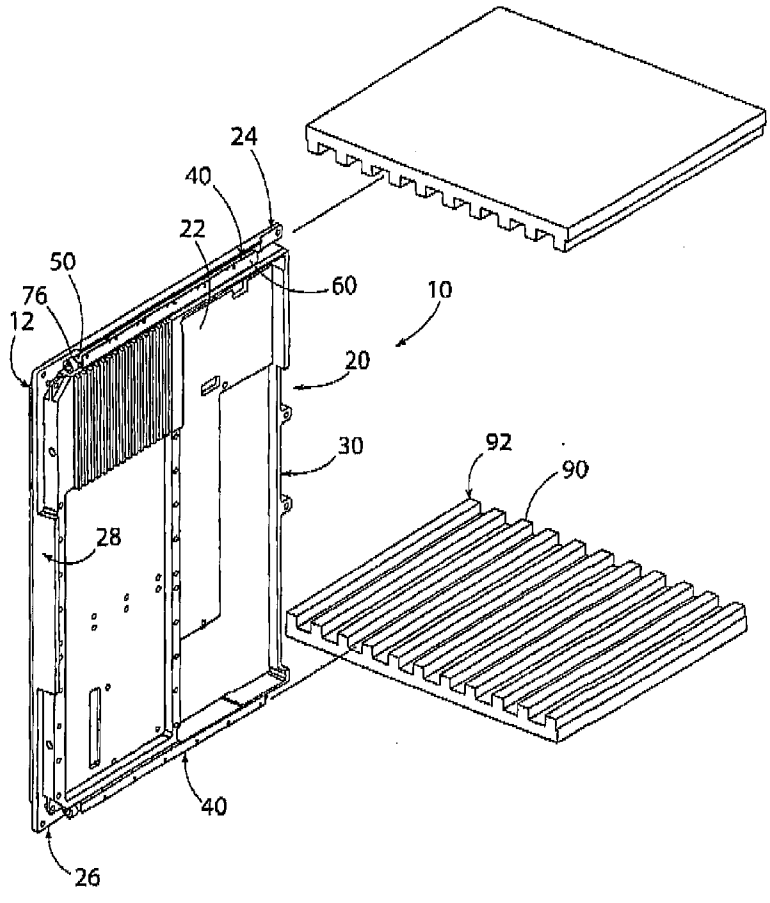
(54) Title: HEAT TRANSFER PLATE WITH RETAINER ASSEMBLY



(57) Abstract: A heat transfer plate adapted for direct contact with heat-generating electronic devices on a circuit board and including a pair of retainer assemblies adapted to releasably retain the plate within an electronic enclosure structure in a relationship wherein the edges of the plate are positioned in a direct, compressive, surface-to-surface relationship with the cold wall of the electronic enclosure structure to allow the direct transfer, via conduction, of the heat generated by the electronic devices on the circuit board from the edges of the plate into the cold wall. The retainer assembly comprises, among other elements, a rotatable rod with a head defining an interior cavity adapted to receive the head of a standard tool for rotating the rod.

WO 2008/033297 A2

PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

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— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

Published:

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HEAT TRANSFER PLATE WITH RETAINER ASSEMBLY

Cross-Reference to Related Application

This application claims the benefit of the filing date of U.S. Provisional Application Serial No. 60/843,981 filed on September 12, 2006, which is explicitly incorporated herein by reference as are all references cited therein.

Field of the Invention

This invention relates generally to a heat transfer plate and, more specifically, to a heat transfer plate with a retainer assembly.

Background of the Invention

Several different structures are currently known and used for spreading, transferring and dissipating heat generated by electronic components and devices mounted to circuit boards.

For example, as disclosed in U.S. Patent Nos. 4,979,073 and 5,200,882, heat generated by electronic devices on circuit boards is commonly transferred to the circuit board and then to the cold wall of an electronic circuit board enclosure structure by way of a circuit board retainer assembly which requires the use of specially designed tools to rotate the rod element thereof.

Heat sinks have also been used to transfer/carry heat away from heat-generating electronic devices. Heat generated from the electronic device is transferred to the heat sink through a direct surface contact between the device and the heat sink. This transferred heat is then dissipated/evaporated to the ambient air through the surfaces of the heat sink exposed to air.

Some of the more elaborate circuit board assemblies have also incorporated metallic heat-spreading/heat-dissipating/heat transfer plates which cover entire circuit board footprints and make direct surface contact with all of the heat-generating electronic devices on the circuit board.

This invention is directed to a heat transfer plate which fully utilizes and takes advantage of the heat transfer characteristics of the cold wall of

the electronic enclosure structure. The invention is also directed to a retainer assembly which does not require the use of any special tools.

Summary of the Invention

The present invention is directed to a heat transfer plate defining peripheral edges and incorporating a retainer assembly adapted to retain the plate within the interior of an electronic enclosure structure in a relationship wherein the peripheral edges of the plate are positioned in direct, compressive, surface-to-surface contact with the cold wall of the electronic enclosure for optimum heat transfer between the plate and the cold wall.

The plate preferably defines at least first and second peripheral edges including first and second retainer assemblies respectively. Each of the first and second retainer assemblies preferably defines a bracket unitary with the first and second peripheral edges respectively, an elongate spring member adapted to be releasably secured to the bracket, and an elongate rod adapted to be seated between the bracket and the spring member.

Each of the shoulders includes at least one surface having a plurality of tabs defined thereon and adapted to be received in respective apertures defined in one of the plates of the spring member. The tabs in cooperation with the apertures locate and secure the respective spring members to the respective shoulders of the heat transfer plate.

The rod of each of the retainer assemblies is rotatable relative to the bracket for deflecting the spring member into contact with the cold wall and clamping the plate against the cold wall in the above recited relationship wherein the at least first and second peripheral edges of the plate are positioned in direct, surface-to-surface, compressive contact with the cold wall of the enclosure.

In accordance with one embodiment of the retainer assembly, the rod is characterized in that it includes a head defining an interior cavity adapted to receive the head of a tool adapted to allow the rod to be rotated between engaged and disengaged positions. The interior cavity of the head may be defined by a hexagonally-shaped interior surface adapted to receive the head of a hexagonally-shaped socket tool. The head of the rod may also

include an outer end surface having a slot defined therein adapted to receive the head of a slotted driver tool. The slot may also serve as a visual engagement indicator.

Other advantages and features of the present invention will be more readily apparent from the following detailed description of the preferred embodiment of the invention, the accompanying drawings, and the appended claims.

Brief Description of the Drawings

These and other features of the invention can best be understood by the following description and the accompanying FIGURES as follows:

FIGURE 1 is a perspective view of a circuit board assembly including a heat transfer plate incorporating the features of the present invention;

FIGURE 2 is a perspective front view of the circuit board assembly of FIGURE 1 with the top retainer assembly shown in exploded form;

FIGURE 3 is a perspective rear view of the circuit board assembly of FIGURE 1 with the top retainer assembly shown in exploded form;

FIGURE 3A is an enlarged, perspective view of the spring member of the retainer assembly shown in FIGURE 3;

FIGURE 3B is an enlarged, exploded, perspective view of the top of the heat frame and spring member of the top retainer assembly;

FIGURE 4 is a broken, side elevational view of the rear of the circuit board assembly of FIGURE 1 and, more specifically, the heat transfer plate thereof, in its engaged, retained position against the cold wall of an electronic circuit board enclosure structure;

FIGURE 4A is an enlarged, broken, vertical cross-sectional view of the lower shoulder of the heat transfer plate and the bottom retainer assembly depicting the relationship and interaction between the rod pin, spring member slot, and shoulder groove in the engaged position of the retainer assembly adjacent the lower portion of the circuit board enclosure structure;

FIGURE 5 is a broken, side elevational view of the back of the circuit board assembly and, more specifically, the heat transfer plate thereof, in its

disengaged, retained position against the cold wall of the electronic circuit board enclosure structure;

FIGURE 5A is an enlarged, vertical cross-sectional view of the lower shoulder of the heat transfer plate and the bottom retainer assembly depicting the relationship and interaction between the rod pin, spring member slot, and shoulder groove in the disengaged position of the retainer assembly;

FIGURE 6 is an enlarged, broken, side elevational view of the head of the rod of the lower retainer assembly associated with the heat transfer plate of the present invention with the rod in its engaged position against the cold plate of the electronic circuit board enclosure structure;

FIGURE 6A is an enlarged, broken, perspective view of the head of the rod shown in FIGURE 6; and

FIGURE 7 is an enlarged, broken, side elevational view of the rear end of the rod of the lower retainer assembly of the heat transfer plate of the present invention.

Detailed Description of the Preferred Embodiment

While this invention is susceptible to embodiment in many different forms, this specification and the accompanying FIGURES disclose only one embodiment as an example of the invention. The invention is not intended to be limited to the embodiment so described, however. The scope of the invention is identified in the appended claims.

FIGURES 1 and 2 show a complete circuit board assembly 10 incorporating one embodiment of a heat transfer/dissipating/spreader plate or frame 20 constructed in accordance with the present invention. As shown therein, circuit board assembly 10 includes a circuit board 12, electronic devices 13 adapted to be mounted to the surface of circuit board 12, and heat transfer/spreader plate 20. Devices 13 are sandwiched between circuit board 12 and heat spreader plate 20.

Plate 20 is generally constructed of a suitable metallic material with optimum heat transfer characteristics and includes a generally rectangularly-shaped central body 22 which defines a pair of opposed peripheral, elongate,

top and bottom, generally horizontal edges or shoulders 24 and 26 respectively and a pair of opposed peripheral elongate, generally vertical, side edges or shoulders 28 and 30.

Each of the shoulders 24 and 26 defines a generally vertical exterior surface 73 (FIGURE 3), a generally vertical interior face 25 and a generally horizontal face or ledge 27 (FIGURES 3B, 6, and 7) orientated and extending unitarily outwardly from the interior face 25 in a relationship generally normal thereto. Horizontal face 27 of each of the shoulders 24 and 26 includes a plurality of spaced-apart, co-linear fingers or tabs 29 (FIGURES 2 and 3B) protruding outwardly therefrom and extending along the length thereof. In the embodiment shown, face 27 of shoulder 24 includes a total of six tabs or fingers 29. Although not shown in any of the drawings, it is understood that face 27 of shoulder 26 likewise includes identically structured and oriented tabs 29.

As shown in FIGURES 1 and 2, plate 20 is adapted to cover the entire footprint of circuit board 12 and thus also defines one or more recesses (not shown) adapted to match the shape and outline of the one or more respective heat-generating electronic devices on circuit board 12. The number and shape of the various electronic devices on a particular circuit board 12 of course determines the number and shape of the one or more respective recesses in the body 22 of plate 20.

In accordance with the present invention, each of the peripheral top and bottom plate edges or shoulders 24 and 26 incorporates and includes a retainer/heat transfer assembly 40 (FIGURE 1) as described in more detail below.

Retainer assembly 40 initially includes a pair of elongate brackets 42 (FIGURES 3B, 4, 5, 6, and 7) which are unitary with, and protrude outwardly from, the generally vertical interior face 25 of respective plate edges or shoulders 24 and 26. Respective brackets 42 extend the length of each of the respective edges 24 and 26 and each includes an outer cylindrically curved and recessed surface 44 (FIGURES 3B, 4, 5, 6, and 7) which defines a cam or cradle adapted to receive a retainer rod 50 as described in more detail below.

Each of the brackets 42 additionally defines an elongate, generally horizontal slot 49 (FIGURES 6 and 7 depict the slot 49 in bracket 42 of lower shoulder 26) which protrudes and extends inwardly into the body thereof in the direction of, and in an orientation generally normal to, the interior face 25 of each of the respective shoulders 24 and 26. Each of the slots 49 extends the full length of the respective edges 24 and 26. Slot 49 is defined in a region of the bracket 42 above the cradle 44 and adjacent, and parallel to, the interior face 27 of each of the respective shoulders 24 and 26.

Each of the brackets 42 still further defines a pair of spaced-apart and generally parallel grooves or recesses 45 (FIGURES 2 and 3B depict recesses 45 in bracket 42 of shoulder 24) formed in the cradle surface 44 and extending in an orientation generally normal to slot 49, interior face 27, and interior face 25. In the vertical direction, each of the grooves 45 extends through a portion of shoulder interior face 27 and all of the cradle surface 44 and terminates adjacent the top edge of respective shoulders 24 and 26. In the horizontal direction, grooves 45 extend between the cradle surface 44 and the back exterior shoulder surface 73 (FIGURE 3) so as to define two respective spaced-apart, parallel through-holes in the respective shoulders 24 and 26. The grooves 45 are spaced apart along the length of respective edges 24 and 26 in a relationship wherein one of the grooves 45 is located proximal to the plate edge 28 and the other of the grooves 45 is located proximal to the opposite plate edge 30.

Each of the retainer assemblies 40 further comprises an elongate, generally "L" shaped spring member 60 (FIGURES 2-7) which is preferably made of a resilient or spring material. As shown in FIGURES 3A, 3B, and 6, each of the spring members 60 defines a first elongate generally horizontal arm or plate 62 adapted to be at least partially seated adjacent to interior face 27 of respective shoulders 24 and 26 and, more specifically, fitted and retained in the slot 49 in bracket 42. Each of the spring members 60 additionally defines a second elongate arm or plate 64 which extends in a relationship generally normal to the plate 62 (in the relaxed orientation of spring member 60 as shown in FIGURES 3A, 3B, and 5) and is adapted to

engage against the cold wall 90 of electronic enclosure structure 92 as shown in FIGURES 4 and 6 and described in more detail below.

Each of the spring members 60 still further defines a plurality of generally oval-shaped apertures 66 (FIGURES 3, 3A, and 3B depict the apertures 66 in the spring member 60 of top retainer assembly 40) extending along the length of the plate 62 in spaced-apart and co-linear relationship. In the embodiment shown, each of the spring members 60 defines six apertures 66. As shown in FIGURES 6 and 7 which depict lower retainer assembly 40 secured to lower shoulder 26, each of the spring members 60 is adapted to be fitted and secured to the interior face or ledge 27 of each of the shoulders 24 and 26 in a relationship wherein the distal peripheral edge of plate 62 is fitted into the slot 49 in respective shoulder brackets 42; the outer surface of plate 62 is seated against the outer surface of shoulder face 27; and the respective tabs 29 on the face or ledge 27 of respective shoulders 24 and 26 are fitted in the respective apertures 66 defined in the plate 62 of respective spring members 60 (FIGURE 3B) for locating and securing the respective spring members 60 to the respective shoulders 24 and 26.

Each of the spring members 60 still additionally defines a plurality of slots 69 (FIGURE 3A depicts the slots 69 in the spring member 60 of top retainer assembly 40) extending inwardly from the peripheral distal elongate edge of the arm 62 in an orientation and direction generally normal to the respective apertures 66. In the embodiment shown, a total of six slots 69 extend along the length of arm 62 in spaced-apart and parallel relationship. A slot 69 is defined between each pair of apertures 66. Two of the slots 69 are located along the length of the respective spring members 60 in a relationship wherein such slots 69 are aligned with the respective grooves 45 defined in the respective shoulders 24 and 26 when the spring members 60 are slid into the slot 49 of respective shoulders 24 and 26.

The arm 64 of each of the spring members 60 likewise defines a plurality of slots 71 (FIGURES 3A and 3B depict the slots 71 in the spring member 60 of top retainer assembly 40) extending inwardly from the distal peripheral edge thereof. Slots 71 extend along the length of arm 64 in

spaced-apart and parallel relationship. In the embodiment shown, arm 64 includes a total of five slots 71. The arm 64 of each of the spring members 60 additionally defines a plurality of circular apertures 75 (FIGURES 3A and 3B depict the apertures in the arm 64 of the spring member 60 of top retainer assembly 40) defined therein and extending along the length thereof in spaced-apart and co-linear relationship.

As particularly shown in FIGURES 4, 5, 6, and 7, respective rods 50 are adapted to be fitted and seated in the cradle 44 defined by each of the respective brackets 42 in a relationship wherein rod 50 is wedged and snapped into the space defined between the bracket 42 and the arm 64 of spring member 60.

Each of the rods 50 has a non-circular, generally oval cross-section. A pin 72 (FIGURES 2 and 3 depict the pin 72 of the rod 50 of top retainer assembly 40) extends through the body of each of the rods 50 and is adapted to extend through one of the slots 69 in arm 62 of respective spring members 60 and into the one of the grooves 45 in respective cradles 44 defined in respective shoulders 24 and 26. The cooperation and interaction between pin 72, slot 69, and groove 45 as shown in FIGURES 4A and 5A limits the rotation of the rods 50 to approximately one-quarter of a revolution (90 degrees) relative to the brackets 42.

As each of the rods 50 is rotated approximately 90 degrees from the relaxed spring configuration of FIGURES 5 and 5A to the activated, engaged clamped configuration of FIGURES 4, 4A, 6 and 7, the longitudinal axis of the respective rods 50 shifts from a position generally normal to the shoulder surface 27 of respective shoulders 24 and 26 (FIGURE 5A shows lower shoulder 28) where the end of the pin 72 is engaged adjacent the end of the slot 69 in spring member 60 and the interior surface of groove 45 defined in shoulder face 27 to a position generally parallel to the shoulder surface 27 of respective shoulders 24 and 26 (FIGURE 4A) wherein the end of the pin 72 has traveled approximately 90 degrees through the groove 45 defined in respective shoulders 24 and 26 and into engagement with the retainer face of the groove 45. The ends of the groove 45 of course limit and assist the movement of rod 50. The amount by which the spring members 60 are

deflected outwardly is greater than the difference between the lengths of the major and minor axes of respective rods 50.

The obtuse angle between the respective arms 62 and 64 of respective spring members 60 is such that a spring tension against respective rods 50 holds the respective rods 50 in their desired operable position.

As shown in FIGURES 4, 6 and 7, it is understood that in the expanded, activated configuration of retainer assembly 40, the arm 64 of respective spring members 60 is adapted to flex into direct, frictional, surface-to-surface contact with and against the respective top and bottom cold walls 90 of electronic enclosure structure 92 so as to firmly and tightly releasably retain the circuit board assembly 10 and, more specifically, the heat plate 20 thereof, within said electronic enclosure structure 92 and provide a direct, compressive, surface-to-surface contact between the outer face or surface 73 (FIGURES 6 and 7) of each of the respective edges or shoulders 24 and 26 of the plate 20 and the inner surface of the cold walls 90 so as to assure optimum conduction type heat transfer between the respective plate edges 24 and 26 and the cold walls 90.

Still further, at least one of the ends of the respective rods 50 has a diameter which is greater than the diameter of the remainder of the respective rods 50 so as to define a head 76 as shown in FIGURES 1 and 2 and FIGURES 6 and 6A which depict the head 76 of the rod 50 of top retainer assembly 40. The head 76 defines a circumferentially extending, generally circular exterior surface 79 (FIGURE 6A) and an interior aperture or cavity defined by a hexagonally-shaped interior surface 81 (FIGURES 6 and 6A) adapted to receive the head of a standard hexagonal socket tool such as, for example, an Allen type socket. The interior surface 81 could, of course, define any other suitable surface adapted to interact with the head of any other type of standard tool used to tighten of loosen screws or the like, such as, for example, a Phillips head.

The incorporation of an industry-standard interior socket-head (or any other like industry-standard head) to the end of respective rods 50 allows rods 50 to be more easily rotated with a greater force/torque (for either

engaging or disengaging the respective retainer assemblies) than that of, for example, the pinned rod embodiment described in, for example, U.S. Patent Nos. 4,979,073 and 5,200,882. With today's retainer assemblies, if the pin on the rod breaks, the retainer assembly cannot be activated. With the present invention, however, rods 50 can be rotated with standard pliers (by securing the head and teeth of standard pliers to the outer head surface 79 and then rotating) even when the internal hex on the socket-head 76 is damaged.

The head 76 additionally defines a pair of co-linear, diametrically opposed slots 79a and 79b defined in an outer end face 83 thereof (FIGURES 6 and 6A depict the head 76 of the rod 50 of top retainer assembly 40) and extending on opposite sides of the interior surface 81. Each of slots 79a and 79b extends between the exterior and interior head surfaces 79 and 81. Slots 79a and 79b serve the purpose of providing a visual rotational engagement reference indicator adapted to allow a user to determine the rotational position of the rods 50 when either tightening or loosening the retainer assemblies. In the disengaged position of rod 50, slots 79a and 79b are oriented generally vertically as shown in FIGURE 6A while, in the engaged position of rod 50, slots 79a and 79b are oriented generally horizontally. The slots 79a and 79b also define an entry point for the head of a slotted screw driver, thus allowing a user to tighten or loosen the rod 50 with a standard slotted screw driver.

Numerous variations and modifications of the embodiments described above may be effected without departing from the spirit and scope of the novel features of the invention. No limitations with respect to the specific plate and retainer assembly illustrated herein are intended or should be inferred.

For example, it is understood that the invention encompasses the embodiment wherein the retainer assembly, rather than being unitary with the heat transfer plate, is a separate assembly adapted to be secured to the respective shoulders 24 and 26 of the plate 20.

What is claimed is:

1. A heat transfer plate defining peripheral edges and incorporating a retainer assembly adapted to retain the plate within the interior of an electronic enclosure structure in a relationship wherein said peripheral edges of said plate are positioned in direct, compressive, surface-to-surface contact with the cold wall of the electronic enclosure for transferring heat between said edges and the cold wall.

2. The heat transfer plate of claim 1 wherein said plate defines at least first and second peripheral edges including first and second retainer assemblies respectively associated therewith.

3. The heat transfer plate of claim 2 wherein each of said first and second retainer assemblies defines a bracket unitary with said first and second peripheral edges respectively.

4. The heat transfer plate of claim 3 wherein each of said first and second retainer assemblies further comprises an elongate spring member adapted to be releasably secured to said bracket and an elongate rod adapted to be seated between said bracket and said spring member, said rod being rotatable relative to said bracket for deflecting said spring member into contact with the cold wall and clamping said plate against the cold wall in said relationship wherein said at least first and second peripheral edges of said plate are positioned in said direct, surface-to-surface, compressive contact against the cold wall.

5. The heat transfer plate of claim 4 wherein said spring member includes a plate defining at least one aperture, each of said edges of said heat transfer plate defining a surface including at least one finger adapted to be received in said at least one aperture in said spring member for locating and securing said rods to said respective edges of said heat transfer plate.

6. The heat transfer plate of claim 5 wherein the plate of said spring member defines a plurality of apertures extending along the length thereof in spaced-apart and co-linear relationship, each of said edges of said heat transfer plate defining a generally horizontal surface including a plurality of said fingers extending along the length thereof in spaced-apart, co-linear relationship and adapted to be received in said plurality of apertures respectively.

7. A plate adapted to cover one or more heat-generating devices mounted on a circuit board and further adapted to be slid into contact with the cold wall of an electronic enclosure structure, the plate comprising:

a) a body defining at least one surface in direct contact with the one or more heat-generating devices on the circuit board;

b) at least first and second peripheral edges adapted to be slid into

contact with the cold wall of the electronic enclosure structure;

c) at least a first retainer assembly extending along one of said

first and second peripheral edges of said plate, said first assembly being adapted to clamp said plate against the cold wall of the electronic enclosure in a relationship wherein at least one of said first and second peripheral edges thereof is positioned in direct, compressive, surface-to-surface contact with the cold wall for transferring heat from said edges of said plate into the cold wall of the electronic enclosure structure.

8. The plate of claim 7 further comprising a second retainer assembly

extending along the other of said first and second opposed peripheral edges.

9. The plate of claim 8 wherein each of said first and second retainer assemblies includes an elongate shoulder unitary with said respective first and second peripheral edges of said plate, said shoulder

defining a cradle, an elongate slot extending the length of said shoulder, at least a first groove in said cradle extending in an orientation generally normal to said slot and at least one finger extending outwardly from said shoulder, each of said first and second retainer assemblies further including an elongate spring member having a first elongate arm defining at least one aperture and adapted to be slid into said slot in said shoulder in a relationship wherein said at least one finger in said shoulder is received in said at least one aperture in said first arm of said spring member, each of said first and second retainer assemblies further including an elongate rod having a non-circular cross-section and being adapted to be seated in said cradle between said shoulder and a second elongate arm of said spring member, said rod being rotatable to force said second arm of said spring member to clamp against the cold wall of the electronic enclosure structure for releasably retaining said plate in the electronic enclosure structure in said relationship wherein said first and second peripheral edges of said plate are positioned in said direct, compressive, surface-to-surface contact with the cold wall.

10. The plate of claim 9 wherein said first arm of said spring member includes at least a first slot defined therein, each of said first and second retainer assemblies further comprising a pin extending through said rod and protruding through said slot in said spring member and into said groove in said cradle of said shoulder for limiting the rotation of said rod relative to said shoulder.

11. The plate of claim 7 wherein said first retainer assembly includes a rod having a distal head including an interior surface defining a cavity adapted to receive the head of a tool adapted to allow the rod to be rotated.

12. The plate of claim 7 wherein said first retainer assembly includes a rod having a distal head including an end face defining a slot.

13. An assembly adapted to retain a circuit board structure within an enclosure, said assembly comprising at least a bracket, a spring member releasably secured to said bracket, and a rod adapted to rotate relative to said bracket and deflect said spring member into engagement against the cold wall of the enclosure for releasably retaining said circuit board structure in the enclosure, said rod being characterized in that it includes a head defining an interior cavity adapted to receive the head of a standard tool.

14. The assembly of claim 13 wherein said interior cavity of said head of said rod is defined by a hexagonally-shaped interior surface adapted to receive the head of a hexagonally-shaped socket tool.

15. The assembly of claim 13 wherein said head of said rod includes an outer end surface defining a slot therein adapted to receive the head of a slotted driver tool.

16. The assembly of claim 13 wherein said head of said rod includes an outer end surface defining a visual rod position indicator.

FIGURE 1

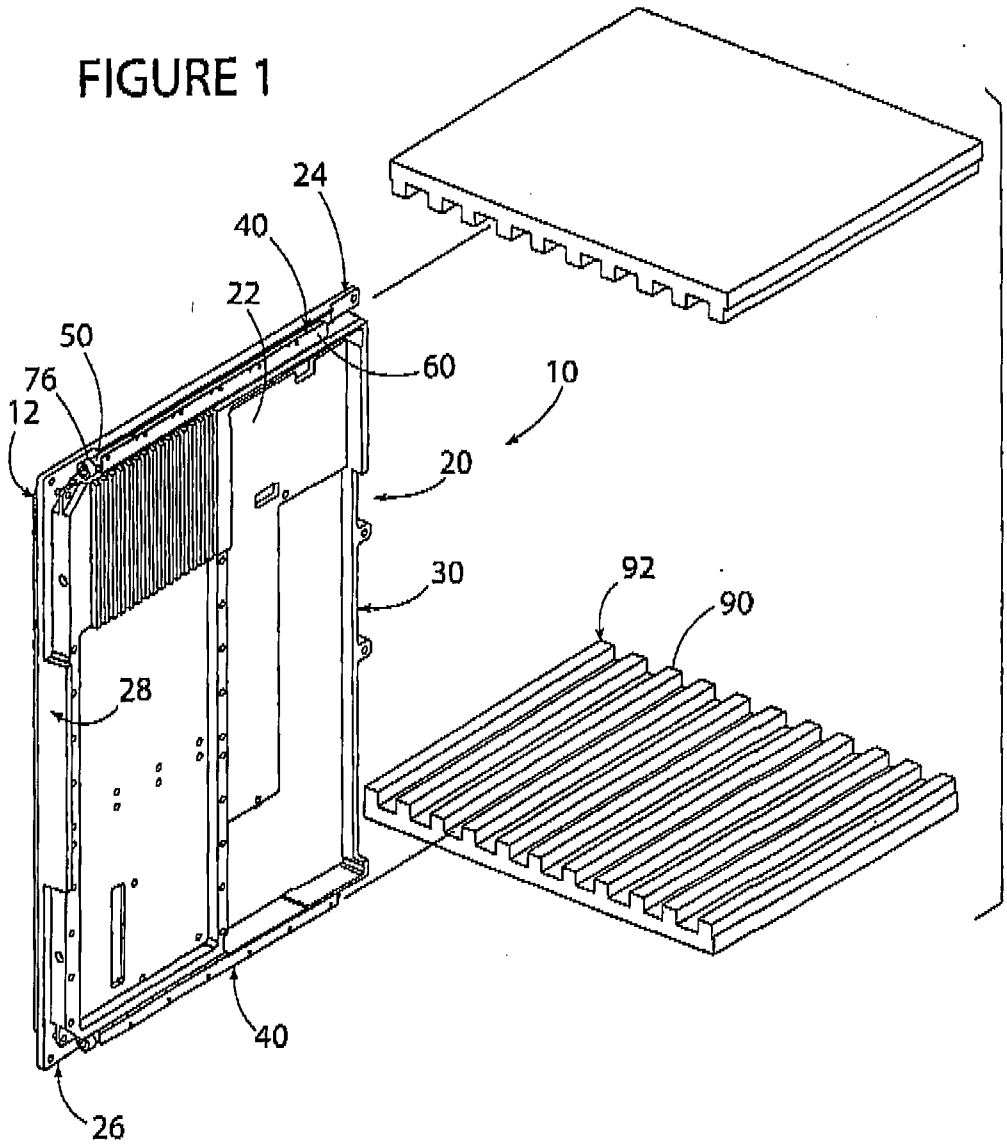


FIGURE 2

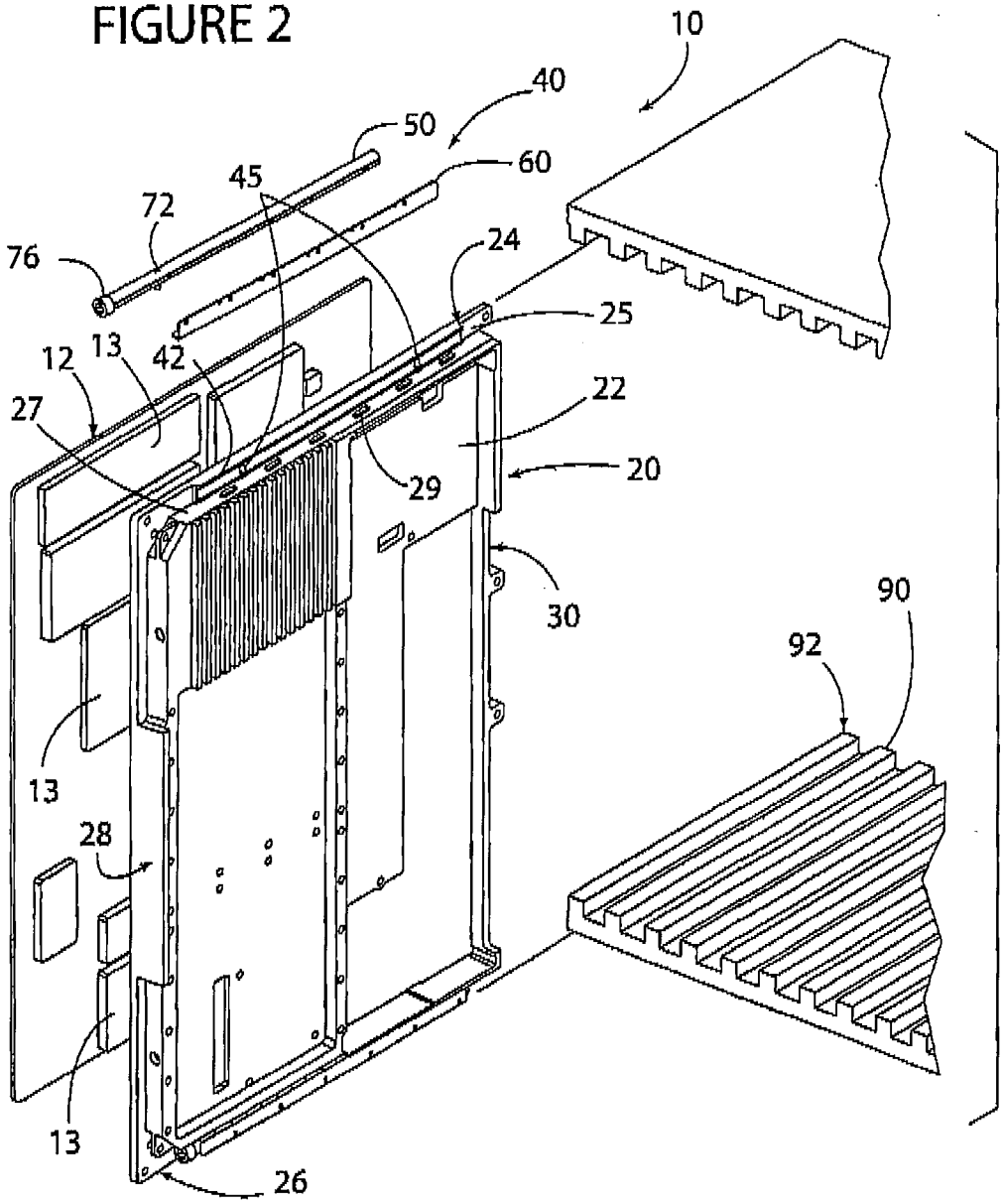
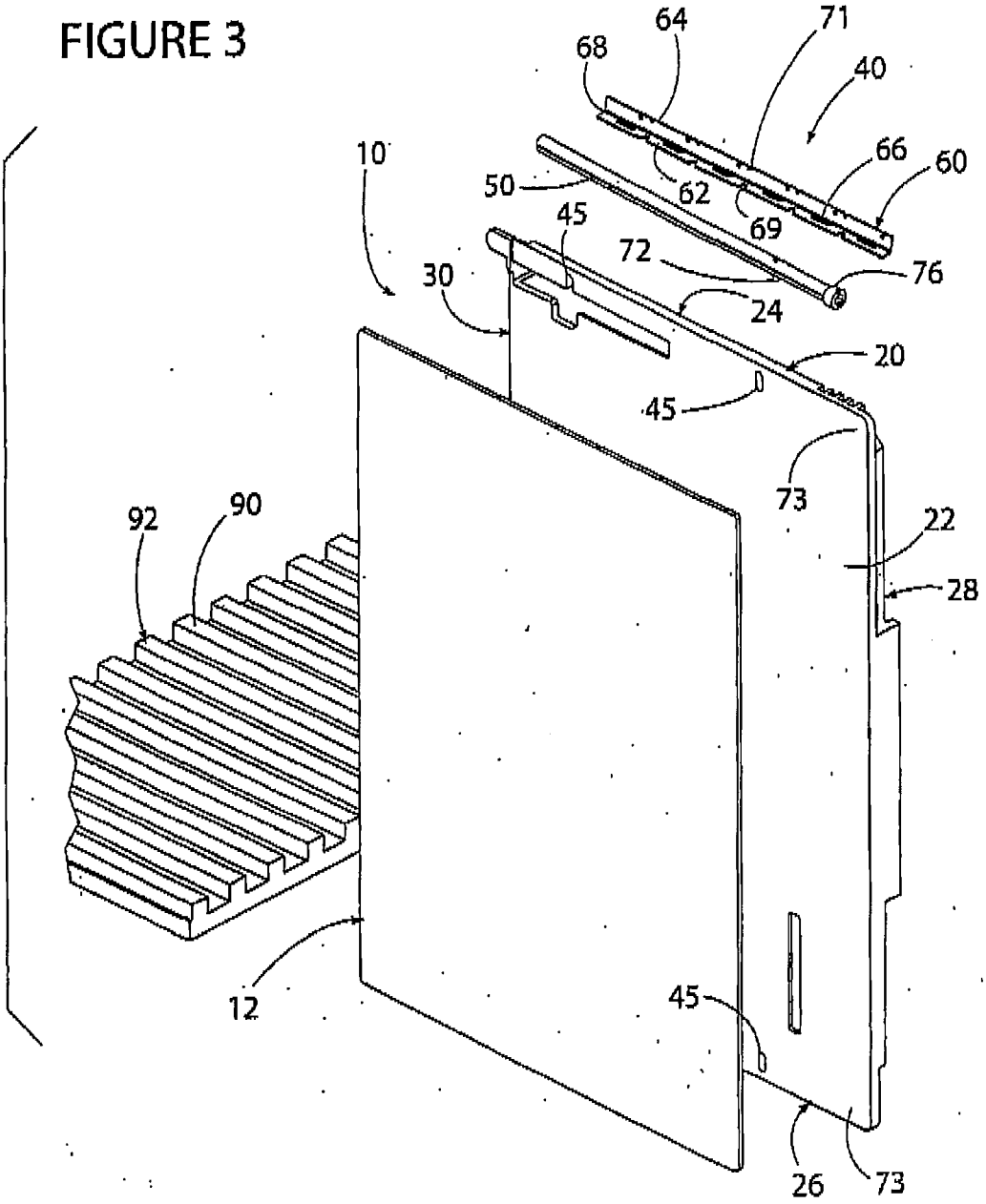


FIGURE 3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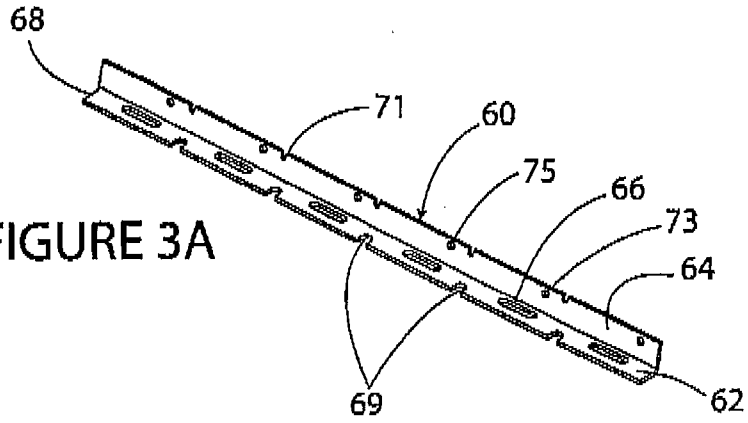

FIGURE 3A

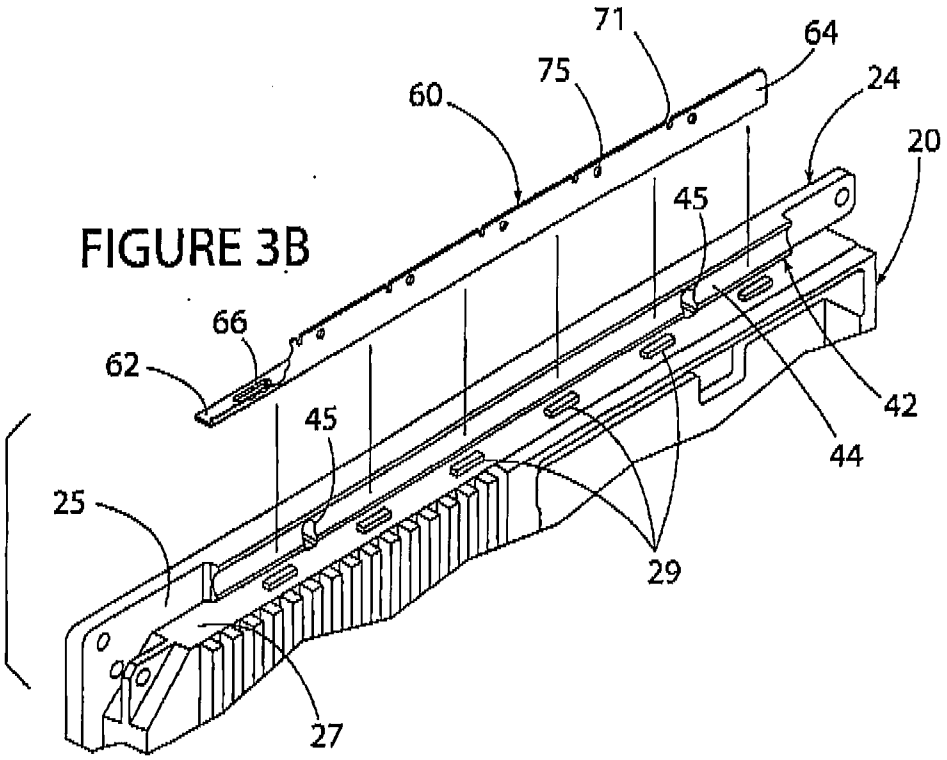

FIGURE 3B

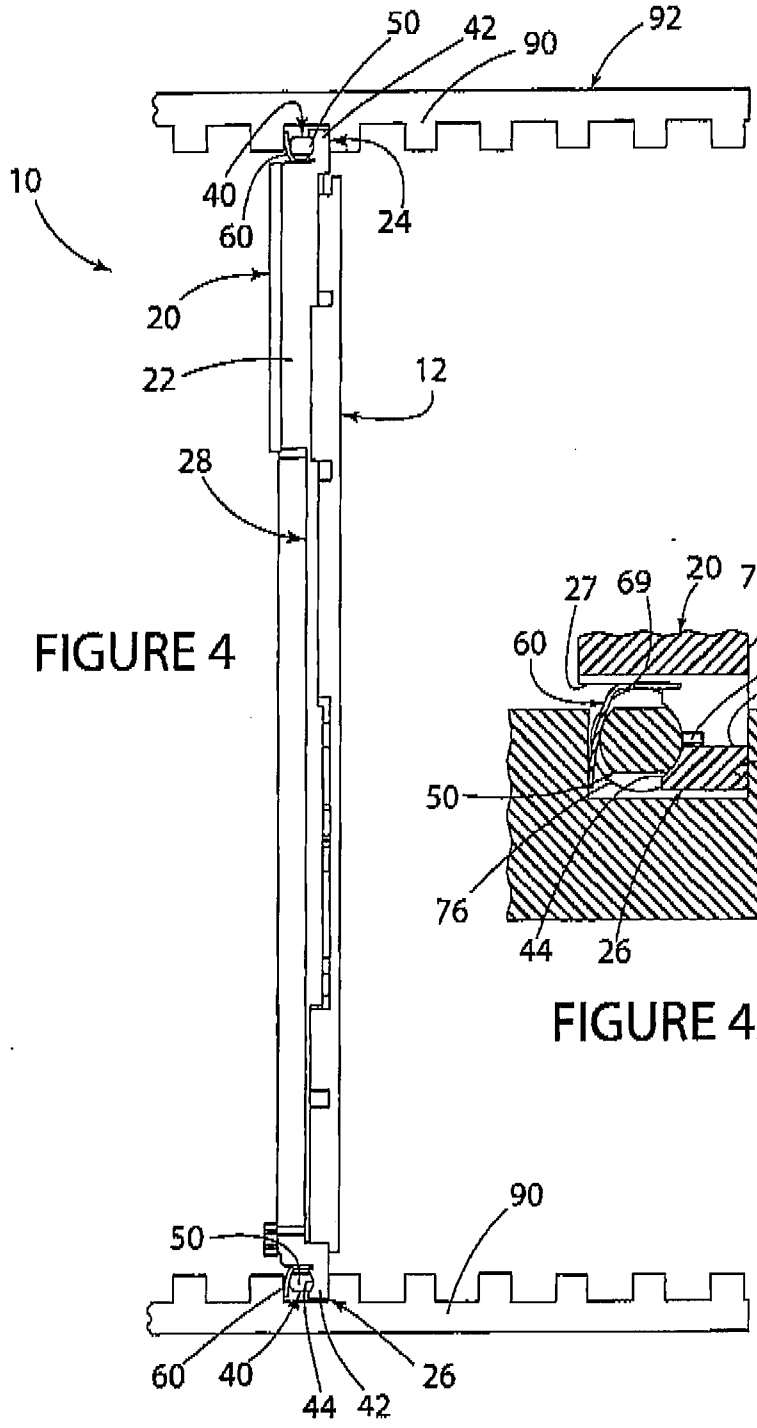

FIGURE 4

FIGURE 4A

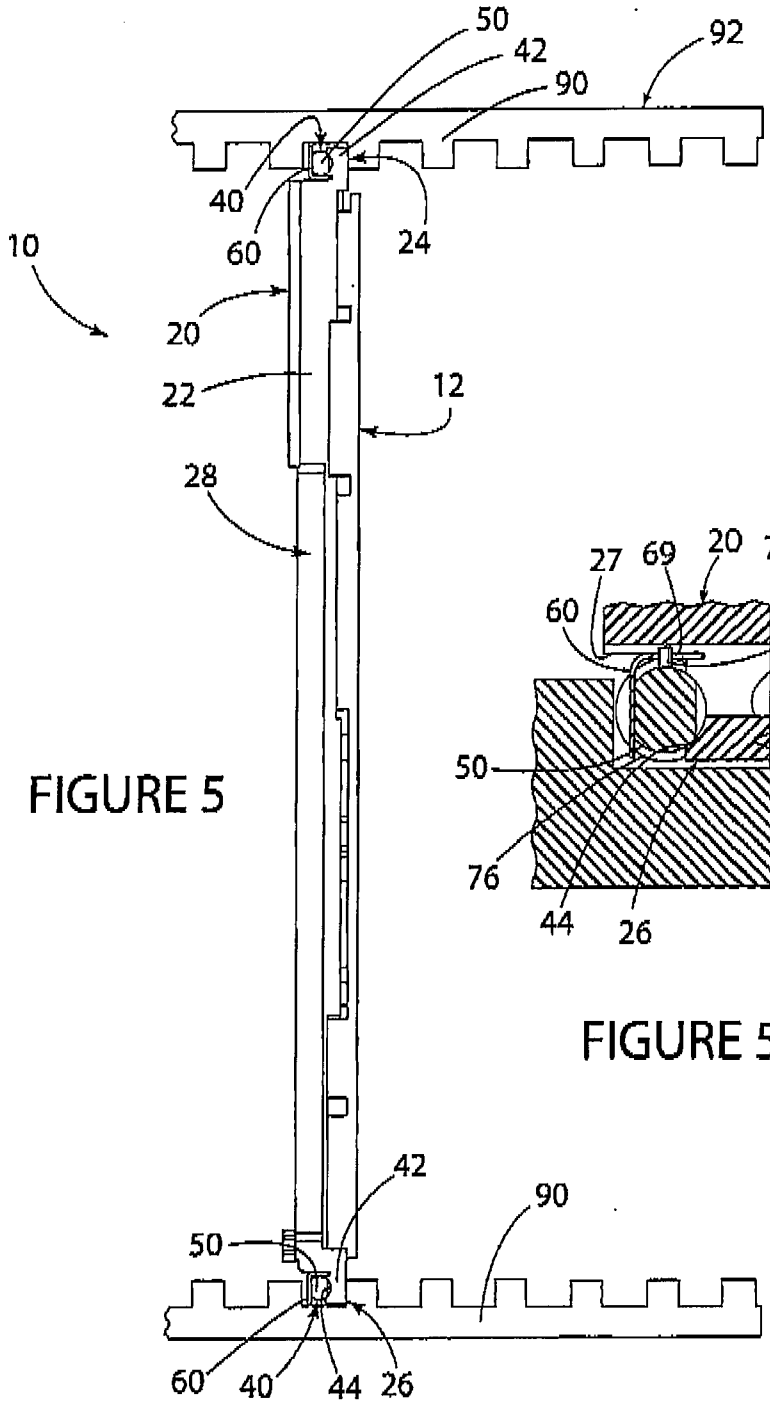

FIGURE 5

FIGURE 5A

FIGURE 6A

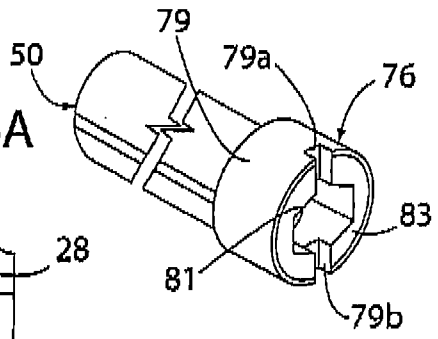

FIGURE 6

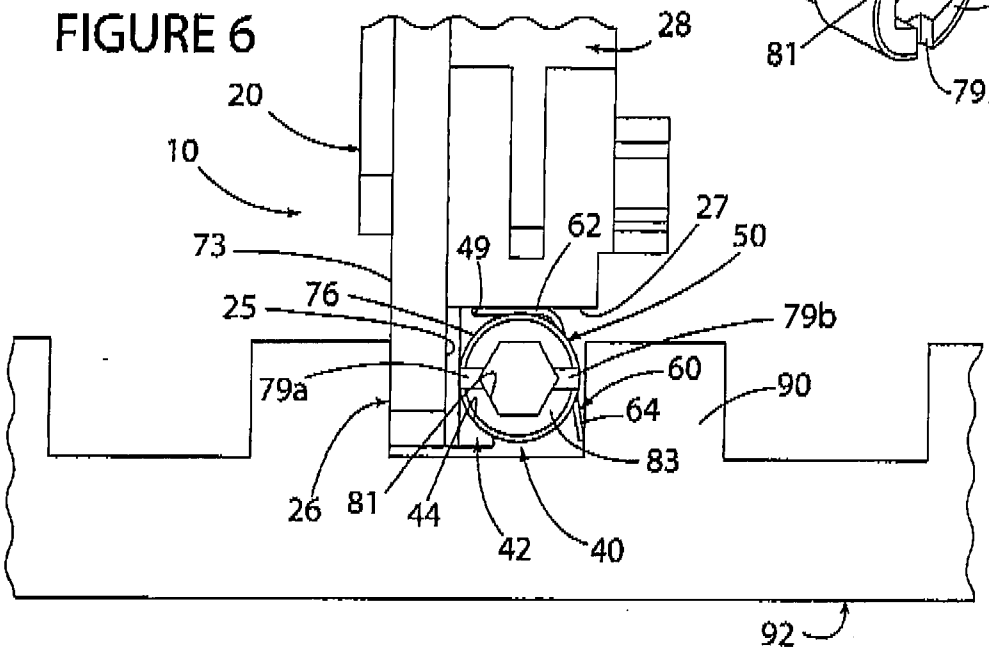

FIGURE 7